

Rapid Assessment Reference Condition Model

The Rapid Assessment is a component of the LANDFIRE project. Reference condition models for the Rapid Assessment were created through a series of expert workshops and a peer-review process in 2004-2005. For more information, please visit www.landfire.gov. Please direct questions to helpdesk@landfire.gov.

Potential Natural Vegetation Group (PNVG):

R7NESF

Northeast Spruce-Fir Forest

General Information

Contributors (additional contributors may be listed under "Model Evolution and Comments")

Modelers

Alison Dibble adibble@fs.fed.us
Rick Vollick rick_vollick@fws.gov
Nort Phillips tphillips@fs.fed.us

Reviewers

Joshua Royt jroyte@tnc.org
Erin Small esmall@fs.fed.us
Dan Grenier

Vegetation Type

Forested

Dominant Species*

PIRU POGR4
ABBA ACRU
BEPA
POTR5

General Model Sources

- Literature
 Local Data
 Expert Estimate

LANDFIRE Mapping Zones

64
65
66

Rapid Assessment Model Zones

- | | |
|-----------------------------------------------|--------------------------------------------|
| <input type="checkbox"/> California | <input type="checkbox"/> Pacific Northwest |
| <input type="checkbox"/> Great Basin | <input type="checkbox"/> South Central |
| <input type="checkbox"/> Great Lakes | <input type="checkbox"/> Southeast |
| <input checked="" type="checkbox"/> Northeast | <input type="checkbox"/> S. Appalachians |
| <input type="checkbox"/> Northern Plains | <input type="checkbox"/> Southwest |
| <input type="checkbox"/> N-Cent.Rockies | |

Geographic Range

Especially in Maine, but also in New Hampshire, Vermont and the Adirondacks of New York. [Southward at higher elevations in the Appalachians might be covered by FRCC model ESPF1]. This model might be relevant in eastern and central Canada, in a band stretching from Newfoundland and central Labrador, south to New York in the east and to central and northern Alberta in the west. A Autecology of Picea species and spruce budworm dynamics make this model especially pertinent to red spruce (*Picea rubens*).

Biophysical Site Description

Mesic to somewhat xeric sites over a broad range of topographic conditions including ravines, valley flats, sheltered low ridges, open north-facing slopes at high elevations, and steep, exposed slopes. Also occurs on slopes at moderate to high elevation (1800-3500 ft in the N.NE. Soils are usually acidic and species diversity tends to be low. Associated with ground-covering feather mosses where organic layers vary from less than an inch (2 cm) to more than 1 foot (30 cm) in thickness. Pure stands of red spruce, white spruce, or balsam fir are rare, but tend towards climax as pure or mixed associated stands. Soils can be poorly drained silt clay over ledge or large gravel, or can be deep sandy loams (much less common). White spruce is uncommon in the N.NE except along the eastern coast and along major northern stream riparian zones. On steep slopes this type often occur growing in an organic soil perched by a network of roots over rocks and boulders. This type also occur on thin folists; organic soils over boulders.

Vegetation Description

The characteristic species are eastern red spruce (*Picea rubens*), balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*). Common, early-seral associates are paper birch (*Betula papyrifera*) and aspen (*Populus tremuloides* and *P. grandidentata*). Other common associates include sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), beech (*Fagus grandifolia*), northern red oak (*Quercus rubra* -- at least, farther south), eastern hemlock (*Tsuga canadensis*), striped maple (*A. pensylvanicum*), red

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

maple (*A. rubrum*), mountain maple (*A. spicatum*), black spruce (*Picea mariana*). Emergent eastern white pine (*Pinus strobus*) may be present. Short-lived early successional shrubby trees include pin cherry (*Prunus serotina*), and on wet sites speckled alder (*Alnus incana* ssp. *rubra*). Low shrubs often include sweet fern (*Comptonia peregrina* -- an atmospheric Nitrogen-fixer), red and black raspberry (*Rubus* spp.). Two common ferns with reputed allelopathic properties are bracken (*Pteridium aquilinum*) and hay-scented fern (*Dennstaedtia punctilobula*). Red spruce can persist in a shady understory for 100 years (called umbrella spruce), and then quickly fill a gap when an opportunity arises. It can then grow into the canopy over a short period. White and black spruce do not do this. Balsam fir is an early competitor and grows faster than young red spruce, but dies at ca. 90 years or earlier, and the red spruce can then dominate the stand.

Disturbance Description

Fire Regime Group V. A moist, cool climate precludes frequent fire. However, rare fire disturbances are severe and affect large patch sizes, at 150- to 300+-year intervals. Surface fires are extremely uncommon. Fire may occur in the spring or later in the growing season under drought conditions, with the former favoring a pathway to early successional aspen-birch, and this delays spruce-fir regeneration (see Class C). Large fires (10-100 acres) and some wind events could extend class D to 130 years before the paper birch finally senesces and the dense fir understory emerges. It is then a further 50-150 years before the fir either senesces or is knocked back by budworm. Wind events, insect attack and ice storms -- on a small patch to stand scale -- are more important than fire, and they may predispose the forest to fire especially when coupled with drought. Wind disturbance often results in an abundance of mountain ash (*Sorbus decora* and *S. canadensis*) as well as elderberry (*Sambucus pubescens* and *S. canadensis*). Spruce budworm outbreaks today are on a 40 to 60 year cycle -- historic cycle is thought to be much longer. The preferred host plant of spruce budworm is balsam fir, but this native insect also attacks over-mature spruce. Before 1800, outbreaks may have had less epidemic impact than in recent times, and interval between outbreaks was longer. Minor spruce budworm outbreaks are also of considerable importance particularly in classes B and D where fir is at it's peak of attractiveness to the budworm. One or two cycles of budworm over a 50 - 150 year period slowly decreases the dominance or co-dominance of fir and increases in waves the strong dominance of red and potentially some black spruce. Spruce beetle attacks trees > 18 in DBH. Over-mature or stressed spruce is susceptible to witch's broom, *Armillaria*, and in severe outbreaks the stand can collapse. In the Rainbow Flora book, susceptibility to fire is estimated to be highest 5 to 8 years after tree mortality; then flammability gradually decreases as fuel decomposes and new understory develops. Sustained crown fire runs covering several hundred acres can occur, with severe damage at the ground surface, depending on time of year. Drought spring conditions produce the most severe effects, whereas late summer or fall burns may temper effects due to presence of live fuel moisture. In the relatively stable late-closed class, moderate disturbances from wind, spruce budworm, spruce bark beetle, *Armillaria*, and ice storm impact on this community but not to stand-replacing severity.

On deep and coarse glacial outwash where fire return intervals can be quicker and more intense it may take much longer to get back to the Spruce forest type. The more intense fires will often strip organic soils and spruce resulting in red and white pine domination for periods of between 100 and 200 years.

Synergy plays a key role in the fire regimes associated with this model (i.e. spruce budworm outbreak , then a wind event, followed by a fire.

Adjacency or Identification Concerns

The type occurs within a zone influenced by temperature-moderating effects of the Atlantic ocean, high relative humidity, high precipitation (most years), and elevation differences. The type covers species transition zones, and ranges from the Acadian spruce-fir forest, to northern hardwoods to boreal hardwoods

and conifers.

Scale Description

Sources of Scale Data Literature Local Data Expert Estimate

The type occupies patches from a few acres to tens of thousands of acres, depending on growing site quality, soils, elevation, and moisture.

Issues/Problems

The historic distribution of this type, if defined by red spruce dominance, is not well-known. Pollen data from cores are not able to differentiate spruce species. Perhaps there was less abundance of balsam fir and red maple in reference conditions. These two species appear to respond especially well to anthropogenic disturbance. Early successional trees such as red maple and poplar can sucker easily after a fire and/or have windborne seeds.

Model Evolution and Comments

KellyAnn Gorman refined the model with us on Feb 17 2005. This model is based on FRCC Reference Conditions for NESF by William Patterson III. Reviews should be sought especially from Patterson, and also from Robert Seymour and Robert Wagner, both of Department of Forest Ecosystem Science, University of Maine, Orono, and from Charles Cogbill. Some of the descriptive info is based on Chapter 5 in Rainbow Vol. 2, Wildland Fire in Ecosystems, and the FRCC version was prepared by Bill Patterson III.

Peer reviewed by Joshua Royt, Conservation Planner TNC Maine Chapter 04/18/15, Erin Small Fire Planner USDS Forest Service White Mountain/Green Mountain/Finger Lakes National Forest 04/25/05, and Dan Grenier 04/26/05.

Succession Classes
Succession classes are the equivalent of "Vegetation Fuel Classes" as defined in the Interagency FRCC Guidebook (www.frcc.gov).

Class A 10%

Early1 All Structures

Description

The community type, 0-29 years old, occupies an opening that followed stand replacement fire, microburst, or another major disturbance. Young stands characterized by birch (paper, gray) and aspen (trembling, big-tooth). Understory has spruce (red/white/black, but especially red) and balsam fir.

Indicator Species* and Canopy Position

- P1RU Lower
- ABBA Lower
- BEPA Upper
- POTR5 Upper

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 8

Structure Data (for upper layer lifeform)

	Min	Max
Cover	30 %	80 %
Height	Tree Regen <5m	Tree Short 5-9m
Tree Size Class	Seedling <4.5ft	

Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

An example is in Baxter State Park, in the Scientific Forest Management Area, northern Maine.

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

Class B 12%

Mid1 Closed

Description

From A without disturbance. Intermediate stands dominated by birch and aspen with spruce and fir in the understory. Age range 30 – 69 yrs old.

Indicator Species* and Canopy Position

BEPA Upper
POTR5 Upper
PIRU Low-Mid
ABBA Low-Mid

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 9

Structure Data (for upper layer lifeform)

	<i>Min</i>	<i>Max</i>
<i>Cover</i>	60 %	100 %
<i>Height</i>	Tree Short 5-9m	Tree Medium 10-24m
<i>Tree Size Class</i>	Pole 5-9" DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Class C 3%

Mid2 Closed

Description

This alternate successional pathway may follow fire (frequency 175 yrs) in A, and reflects suppressed establishment of spruce-fir. Intermediate stands characterized by birch and aspen. Understory initially LACKS spruce and fir but the conifers establish later in the class, perhaps around 40 years. Class age range: 30-79 yrs.

Indicator Species* and Canopy Position

BEPA Upper
POTR5 Upper
POGRA2 Upper
PIRU Lower

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 5

Structure Data (for upper layer lifeform)

	<i>Min</i>	<i>Max</i>
<i>Cover</i>	40 %	80 %
<i>Height</i>	Tree Regen <5m	Tree Short 5-9m
<i>Tree Size Class</i>	Sapling >4.5ft; <5"DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

If we could have added one more species, it would be ABBA in lower canopy position, with PIRU.

Class D 10%

Late1 Closed

Description

Primary pathway from C, so may have burned. Late closed stand dominated by aspen and birch. Spruce/fir present and gaining dominance. Early-successional hardwoods are in decline. Age range for the class is 80-119 yrs.

Indicator Species* and Canopy Position

BEPA Upper
POTR5 Upper
P1RU Mid-Upper
ABBA Mid-Upper

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 9

Structure Data (for upper layer lifeform)

	<i>Min</i>	<i>Max</i>
<i>Cover</i>	70 %	100 %
<i>Height</i>	Tree Medium 10-24m	Tree Medium 10-24m
<i>Tree Size Class</i>	Pole 5-9" DBH	

- Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

Class E 65 %

Late2 Closed

Description

Closed spruce/fir stand 70-175+ years. Individual fir trees drop out after age 70-100, but spruce and fir regenerate in gaps, eventually to spruce and secondarily to fir. Moderate disturbances from wind, spruce budworm, spruce bark beetle, Armillaria, and ice storm impact on this community but not to stand-replacing severity.

Indicator Species* and Canopy Position

PIRU Upper
ABBA Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	80 %	100 %
Height	Tree Medium 10-24m	Tree Tall 25-49m
Tree Size Class	Large 21-33"DBH	

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Fuel Model 10

Disturbances

Non-Fire Disturbances Modeled

- Insects/Disease
- Wind/Weather/Stress
- Native Grazing
- Competition
- Other:
- Other:

Fire Regime Group: 5

- I: 0-35 year frequency, low and mixed severity
- II: 0-35 year frequency, replacement severity
- III: 35-200 year frequency, low and mixed severity
- IV: 35-200 year frequency, replacement severity
- V: 200+ year frequency, replacement severity

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class. All values are estimates and not precise.

Historical Fire Size (acres)

Avg:
Min:
Max:

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	265	150	300	0.00377	99
Mixed					
Surface					
All Fires	265			0.00379	

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

References

Bergeron, Y. 2000. Species and dynamics in the mixed woods of Quebec's southern boreal forest. Ecology. 81: 1500-1516.

Brown, James K.; Smith, Jane Kapler, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 p.

Heinselman, M. L. 1981. Fire intensity and frequency as factors in the distribution and structure of Northern ecosystems. In: Mooney, H. A., T. M. Bonnicksen, N. L. Christensen, J. E. Lotan, and R. A. Reiners, tech. coords. Fires regimes and ecosystem properties: proceedings of the conference; 1978 Dec 11-15; Honolulu, HI. Gen. Tech. Rep. WO-26, Washington, DC: U.S. Dept. of Agriculture, Forest Service, 7-57.

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit <http://plants.usda.gov>.

Kuchler, A.W. 1964. Northern hardwoods (Acer-Betula-Fagus-Tsuga). #106 In: Manual to accompany the map Potential Natural Vegetation of the United States. New York, NY: The American Geographical Society. 156 p.

Lorimer and White. 2003. Scale and Frequency of natural disturbances in the northeastern US. Forest Ecology and Management: 185:41-64

Patterson, W. A. III, K. E. Saunders and L. J. Horton. 1983. Fire Regimes of the Coastal Maine Forests of Acadia National Park. USDI/NPS - North Atlantic Region Office of Scientific Studies Report OSS 83-3. 259 pp.

U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, December). Fire Effects Information System, [Online 12 February 2004]. Available: <http://www.fs.fed.us/database/feis/>.